the operations of planning, making, lettering, dimensioning, altering, blue-printing, indexing, and preserving drawings, are reduced to a systematic procedure.

The remaining papers, for which, however, but little time remained, were: 'Cross-sectioning with the right-line pen,' J. B. Webb; 'Comparison of three modern types of indicators,' G. H. Barrus; 'A positive speed-indicator,' O. Smith; 'The experimental steel-works at Wyandotte,' W. F. Durfee; 'Early history of the steel-works at Troy,' R. W. Hunt; 'Experiments on non-conducting coverings for steam-pipes,' J. M. Ordway and C. J. H. Woodbury.

Professor Webb's paper referred to methods in use in his drawing-classes, with specimen of work.

Mr. Barrus gave the weights of the parts of the indicators, but neglected their moments of inertia: he compared the general appearance of the diagrams, and the correctness of the parallel motions: the errors of the springs were given, and the action of the drum mechanism discussed by means of an apparatus for detecting changes of phase. Some of these experiments seem to be in the right direction, but no discussion of underlying mechanical principles was attempted. Mr. Smith's machine is a counter for revolving shafts, *with a clock* which throws it in gear for one minute. The other papers will be read and discussed at the annual November meeting in New-York City.

Thursday was devoted to an excursion, by rail, up the Alleghany River for the purpose of visiting various works and furnaces. Among these were the Spang steel and iron company's works, the Isabella furnaces, the National soda-works, and the Plate-glass works, using natural gas as a fuel. A subscription dinner on Thursday evening, and a water excursion up the Monongahela on Friday, completed the programme of this meeting of the society.

DEVELOPMENT OF THE THYROID AND THYMUS GLANDS AND THE TONGUE.

UNDER the wide title of 'Ueber die derivate der embryonalen schlundbogen und schlundspalten bei säugethieren' (*Arch. mikr. anat.*, xxii. 271), G. Born discusses the development of these organs as determined by observations on pig embryos. These valuable researches give us, for the first time, an understanding of the morphology of the two glands of the above title, which have been a long-standing puzzle to comparative anatomists.

The tongue arises from the anterior part of the ventral floor of the pharynx. The space between the ventral ends of the first and second visceral arches is at first depressed; but later a longitudinal ridge grows up, separated on each side, by a groove, from the arches. The anterior portion of this ridge grows out, and becomes the free part of the tongue: the posterior part of the ridge projects between the third and fourth arches, and develops into the epiglottis. It will thus be evident that the tongue does not extend back beyond the second arch. After the embryo (pig) reaches a length of fifteen millimetres, the tongue grows rapidly forward. (Although it has long been known that the tongue arises from the floor of the pharynx, the evident conclusion has not been sufficiently recognized, that the epithelial covering of the tongue is entodermal, and not ectodermal, and therefore not the same as the lining of the mouth, as a continuation of which the lingual epithelium is customarily described.)

The fate of the visceral clefts has been more fully elucidated than heretofore. The *first* becomes the outer and middle ear and the Eustachian tube, as is well known: the fate of the others has been obscure. According to Born, the *second* entirely disappears, becoming first a closed sac, and finally undergoing complete atrophy; the *third* likewise becomes a closed sac, which remains some time connected with the epidermis; from the inner end of the cleft arises a short caecum, extending ventrally inwards and forwards, which is the *anlage* of the thymus, and is retained and enlarged, while the rest of the cleft is atrophied; the *fourth* cleft also remains in part as a closed sac, which later joins in the formation of the thyroid gland.

The thymus was first shown by Kölliker (*Entwickelungsgeschichte*, 2te aufl.) to be an epithelial organ, and probably derived from a gill-cleft. Born traces its origin from the third cleft, as a ventral evagination near the inner opening. The caecum grows, at first, without altering its position or general appearance; but the rest of the cleft is reduced to a small canal, the outer part, indeed, to a solid cord of cells (embryo pigs of about sixteen millimetres). The whole, except the thymus portion, is atrophied, but the outer cords persist for a time. The thymus *anlage* spreads out into a canal, with walls of fine, many-layered epithelium. The lower end of the canal rests against the pericardium, where the aorta makes its exit. In embryos of two centimetres, the lumen of the canal has disappeared, and from the solid cord many branches have grown out, most abundantly at the heart end.

The thyroid gland, as was first shown by W. Muller (*Jenaische zeitschr.*, vi. 428, 1871), has a double origin Born shows that the principal division arises as a median invagination in the floor of the pharynx, on a line with the front edge of the second visceral cleft. Very early this invagination separates from the pharyngeal epithelium, expands laterally chiefly, changes to a network, and at the same time moves backward until it comes to lie behind the glottis. Until the embryo is two centimetres long, the thyroid mass lies near the origin of the third aortic arch (common carotid); but in older embryos the division of the carotids has moved back, away from the head and the thyroid gland. The secondary portion of the thyroid is derived from the paired remnants of the fourth clefts. The median portion of the thyroid early changes into a network of epithelial cords. The outer cells of the cords are cylindrical: the inner cells, in several layers, are not very distinct from one another. Around the cords, the mesoderm forms sheaths of spindle cells, while between them the blood-vessels appear. The lateral *anlagen* become

somewhat pear-shaped, the large end lying ventrally. The lumen is retained until the fusion with the median part is accomplished by the union of the large end of the side components with the central division: the large end soon after assumes the characteristic net-like form of the thyroid gland; but the lateral portions can still be distinguished for some time by the lesser size of the meshes, and the greater size of the cords of the network into which they change.

In the introduction to his article, Born refers to the previous writings of Stieda and Wölfler, and closes with a criticism of the same, and other publications based upon his own researches. The most important point to be noticed is the correction of Wölfler's mistake in describing the second cleft as the first. (In this abstract, the author's arrangement of the matter has not been followed, as it appeared little conducive to clearness). C. S. Minot.

RESEARCHES ON ASTRONOMICAL SPECTRUM-PHOTOGRAPHY.

At the time of his death, in November, 1882, Dr. Henry Draper had, for a number of years, been largely occupied with very tedious and costly investigations connected with the photography of the spectra of the heavenly bodies, his unusual adaptedness for the prosecution of which research conducted him to results of the highest importance. With true scientific spirit, Mrs. Draper has generously placed at the disposal of Professor Young and Professor Pickering all the data necessary for the proper publication of the work; and, in a monograph of about forty pages, the former gives an introduction to Dr. Draper's researches, together with a description of the apparatus with which they were made, extracts from the original note-books, and a list of the photographic plates in Mrs. Draper's possession; while the latter, who took a number of these plates to the observatory of Harvard college in the spring of 1883, presents the results of his measurements, accompanied by a discussion of the plates.

Dr. Draper's attention appears to have been first turned toward spectrum-photography in 1869 and 1870, although his photographic work in other fields previously to this time had been singularly successful. His first work in science, conducted while a medical student in New York, and which related to the function of the spleen, was illustrated with microphotographs of great excellence; and very soon after taking his degree, while on a visit at Parsonstown, Ireland, he became so thoroughly impressed with the photographic possibilities of the great reflecting-telescope of the Earl of Rosse, that, soon after his return home, he began the construction of a metallic speculum of fifteen inches diameter, which was soon replaced by a number of silver-on-glass mirrors of about the same size, the details of the construction and mounting of which formed the subject of one of the Smithsonian contributions to knowledge, published in 1864. Seven years later, he had completed with his own hands the entire construction and mounting of a twenty-eight inch silvered-glass mirror, with which he obtained, in May, 1872, his first photographs of the spectrum of α Lyrae by merely inserting a quartz prism in the path of the rays, just inside the focus of the small mirror, and employing neither slit nor lenses. Three months afterward, the same method secured for him plates showing four lines in the spectrum of the same star. For two or three years following, Dr. Draper's time was, for the most part, occupied with other lines of work, connected with investigations of the solar spectrum, and the superintendence of the photographic preparations for the transit of Venus of 1874. He returned to the subject of stellar spectra in 1876, obtaining a number of photographs with a fine twelve-inch refractor by Alvan Clark & Sons. This instrument, now the lesser telescope of the Lick observatory, was replaced in Dr. Draper's establishment, in 1880, by an eleven-inch Clark refractor, which was provided with a correcting-lens fitted to be placed in front of the object-glass to adapt it to photographic work. This instrument was mounted on the same set of axes with the twenty-eight inch Cassegrain mirror, as were also a finder of five inches aperture, and one of two inches, — all of which are well shown in the picture of the telescopes in the Hastings observatory, vol. i. of *Science*, p. 31.

Dr. Draper's eminent successes in celestial photography were due in large degree to his own skill and discoveries in the manipulation of the sensitized plates. Until 1879, wet collodion plates were used in all his experiments; but after that time he employed exclusively the dry plates made by Wratten & Wainwright, to the admirable performance of which, in the hands of Dr. Huggins, his attention was called by that distinguished astronomical physicist, on a visit of Dr. Draper to England in 1879.

Professor Young directs attention to the fact that the investigations of stellar spectra were by no means carried on continuously, but only during Dr. Draper's summer residence at his country-place, and in the intervals of other, to him, even more absorbingly interesting researches and urgent business occupations. The difficulties proved to be well-nigh insurmountable; for at first the limitations imposed upon the time of exposure by the use of the wet process made it almost impossible to get impressions of sufficient strength, — a difficulty which vanished on the introduction of the modern dry-plate processes: and another difficulty, increasing with the length of the exposure, was that of securing a sufficiently accurate movement of the driving-clock. No less than seven such clocks were constructed before he succeeded in getting a perfect one. Its regulator was a pair of heavy conical pendulums, so hung that their revolutions were sensibly isochronous through quite a range of inclination. The gearing and driving-screw were constructed, for the most part, by Dr. Draper himself, with the utmost care and accuracy; and Professor Young says, that, in its ultimate perfected condition, the driving-clock was as good as any in existence, being able to keep a star upon the slit for an hour at a time, when near the meridian, and not disturbed by changes of refraction.